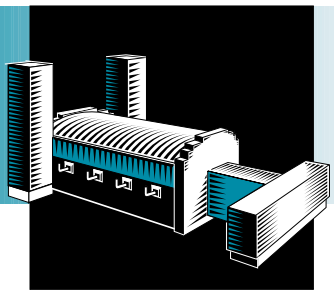
GLASS
Project Fact Sheet



Thermophotovoltaic Electric Power Generation Using Exhaust Heat

Benefits

- Could save 27 billion Btu of electricity per installation annually
- Could save 0.5 trillion Btu annually in the glass industry by 2010
- Converts waste streams into a valuable resource
- Provides onsite electricity generation from industrial waste heat
- Reduces dependence on and emissions from central power-generating facilities
- Improves electrical system efficiency due to onsite generation, avoiding transmission line losses

Applications

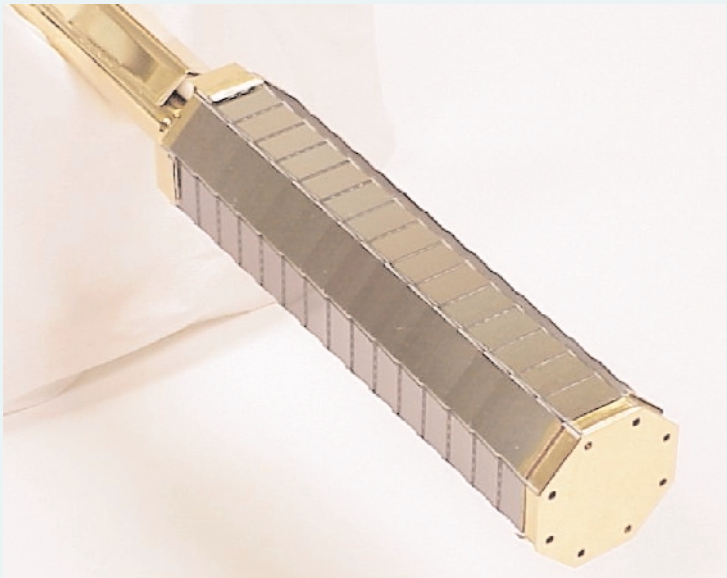
The thermophotovoltaic electric power generation technology is primarily applicable to the glass, metalcasting, and steel industries. These industries produce large amounts of waste heat at high temperatures, which can be used to generate electricity. Other applications for this technology are off-grid residential cogeneration, grid-connected residential cogeneration, and grid-connected residential self-powered furnaces.

Innovative Technology Produces Electricity from Industrial Waste Heat

Furnaces in the glass, metalcasting, and steel industries operate at very high temperatures and lose tremendous amounts of energy in their exhaust streams. With the emissions-reducing shift to gas-oxy furnaces in these industries, exhaust temperatures are climbing even higher. Waste heat from furnaces in the glass, metalcasting, and steel industries is usually vented to the atmosphere. In some facilities, it must be diluted with cool air to reduce its temperature prior to venting. Until now, the venting of this waste heat has represented the loss of a valuable resource.

A new technology adds value to this waste stream by using exhaust heat to generate hundreds of kilowatts of electricity. This unique innovation uses new infrared-sensitive photovoltaic cells mounted inside ceramic tubes. These tubes are heated in the exhaust stream of an industrial process and radiate energy inward to the photovoltaic cells to generate electricity directly from the waste heat. The energy density in these systems is over 100 times that of solar energy, producing over 100 times the energy of conventional photovoltaic or solar cells.

Thermophotovoltaic Electric Power Generator



This new technology, developed by JX Crystals, Inc., produces electricity directly from furnace exhaust waste heat by using infrared-sensitive photovoltaic cells.

Project Description

Goal: Build the first thermophotovoltaic cylinder heated from the outside with a water-cooled thermophotovoltaic array inside.

Thermophotovoltaic technology uses infrared-sensitive photovoltaic cells to directly convert radiant heat to electricity. The technology was not available until 1989, when Boeing personnel (now at JX Crystals) invented and demonstrated the GaSb cell. JX Crystals, Inc., licensed this technology in 1993 and acquired the Boeing team.

Just as solar cells are sensitive to sunlight, JX Crystals' new photovoltaic device is sensitive to infrared radiation from cooler heat sources. When a ceramic element is placed in a flame, it glows, emitting large amounts of infrared radiant energy. If photovoltaic cells are arrayed in view of this infrared source, electric power can be generated quietly and reliably. This new device converts heat to electricity at efficiencies of over 20%.

JX Crystals, Inc., is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Design a thermophotovoltaic demonstrator and prototype cylinder for industrial use.
- Fabricate the thermophotovoltaic demonstrator.
- Test the thermophotovoltaic demonstrator using a laboratory tube furnace.
- Investigate partnering with industry players to demonstrate the technology in situ on an existing glass furnace.

Economics and Commercial Potential

Exhaust heat offers an attractive energy alternative to the glass, metalcasting, and steel industries. In particular, JX Crystals, Inc., has targeted the glass industry because of an estimated 67 MW of year-round electrical generation available in this industry alone. The technology has already attracted the partnership of a major glass-industry player interested in demonstrating the technology on a glass furnace.

Given additional investment in the business and a market volume well over 10 MW per year, JX Crystals, Inc., estimates the thermophotovoltaic circuit to cost approximately $0.20 per watt. Balance of system costs are estimated to be $0.50 per watt. Assuming a price of $1 per watt, utility rates of $0.05 per kWh, and a duty cycle of 90%, the payback period should be less than 3 years.

This technology could save 27 billion Btu of electricity per installed unit each year. First sales for the technology are expected by 2004. Based on 25% market penetration by 2010, annual savings could be 0.5 trillion Btu with 18 units installed, each containing 200 5-kW tubes. Market penetration of 50% by 2020 could save 1.0 trillion Btu from the operation of 37 units by the glass industry.

Industry of the Future—Glass

In April 1996, several organizations representing the glass industry signed a compact with the Department of Energy (DOE) in an effort to encourage technological innovations that will reduce energy consumption, pollution, and production costs in the industry. The glass industry published a report entitled ***Glass: A Clear Vision for a Bright Future,*** *which articulated the industry's vision of its future. This compact set the foundation for collaborative efforts between the industry and the Federal government. Signed by both key industry players and DOE officials, it was a formal commitment to align DOE'S limited resources to meet the challenges identified in the vision.*

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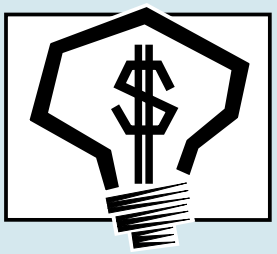

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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